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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/955,738	09/18/2001	Jason H. Hafner	HUV-050.01	9454

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EXAMINER

LISH, PETER J

ART UNIT	PAPER NUMBER
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1754

DATE MAILED: 02/12/2003

9

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/955,738

Applicant(s)

HAFNER ET AL.

Examiner

Peter J Lish

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 07 May 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-36 is/are pending in the application.
- 4a) Of the above claim(s) 26-36 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-25 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☒ Claim(s) 1-36 are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 3,7,8.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

Restriction to one of the following inventions is required under 35 U.S.C. 121:

- I. Claims 1-25, drawn to a method of attaching a single-walled carbon nanotube to the tip of an atomic force microscope, classified in class 422, subclass 55 or alternatively class 73, subclass 105.
- II. Claims 26-36, drawn to a method of growing carbon nanotubes via a chemical vapor deposition process, classified in class 423, subclass 447.3.

The inventions are distinct, each from the other because of the following reasons:

Inventions I and II are unrelated. Inventions I and II are at best related as combination and subcombination. Inventions in this relationship are distinct if it can be shown that (1) the combination as claimed does not require the particulars of the subcombination as claimed for patentability, and (2) that the subcombination has utility by itself or in other combinations (MPEP § 806.05(c)). In the instant case, the combination as claimed does not require the particulars of the subcombination as claimed because single-walled carbon nanotubes of invention I may be grown by methods other than that to which invention II is drawn. The subcombination has separate utility such as growing carbon nanotubes by the chemical vapor deposition of a carbon-containing gas, and then compounding them in a polymer.

During a telephone conversation with Dana Gordon on 1/24/03 a provisional election was made with traverse to prosecute the invention of Group I, claims 1-25. Affirmation of this election must be made by applicant in replying to this Office action. Claims 26-36 are withdrawn from

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further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

It is noted that Mr. Gordon's traversal of the restriction requirement is based on burden of search.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claim 1 is rejected under 35 U.S.C. 102(b) as being anticipated by Kong et al. ("Synthesis of individual ingle-walled carbon nanotubes on patterned silicon wafers").

Kong et al. teach the growth of single-walled carbon nanotubes via chemical vapor deposition. They also teach the imaging of the substrate using AFM. The picking up of a single-walled carbon nanotube by the AFM tip during imaging is seen to be inherent to the process. Therefore, no difference is seen between the process of Kong et al. and that of the applicant.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1 and 20-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Colbert et al. (WO 98/05920) taken with Kong et al. ("Synthesis of individual single-walled carbon nanotubes on patterned silicon wafers").

Colbert et al. disclose a method for the attachment of a single-walled carbon nanotube to the tip of an atomic force microscope (AFM). They teach that by bringing the tip next to the nanotube and performing a translation, the van der Waals forces promote bonding between the nanotube and the tip.

Colbert et al. do not teach any particulars about the nanotube sample which is used, they rather disclose that the nanotube assembly is preferably prepared from isolated, purified carbon nanotubes (page 8, lines 1-11). Kong et al. teach a method of growing perfect, individual single-walled nanotubes on a substrate using a chemical vapor deposition process. It would have been obvious to one of ordinary skill at the time of invention to use the single-walled nanotube assembly of Kong et al. for the process of Colbert et al. in order to provide an isolated and pure single-walled carbon nanotube sample.

Colbert et al. also do not teach a process of imaging the substrate using an atomic force microscope. However, Kong et al. teach that the vapor-grown nanotubes are easily located, characterized, and manipulated with the atomic force microscope (abstract). Furthermore, sample characterization was carried out using an AFM, which resulted in Figures 2 and 3. It would have been obvious to one of ordinary skill at the time of invention to image the substrate using an atomic force microscope, as taught by Kong et al., to locate and characterize the nanotube-substrate sample before proceeding with the attachment process of Colbert et al.

Regarding claims 23-25, Colbert et al. disclose that an adhesive may be applied to the tip prior to the attachment procedure (page 13, line 17 to page 14, line 2). It is further taught that in the

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case of the adhesive requiring a cure, the appropriate conditions, such as UV light, heat, etc. is provided after the nanotube is attached.

Regarding claims 20-22, Kong et al. disclose that the SWNTs have diameters of between 1 and 3 nm. Therefore, it would have been obvious to one of ordinary skill to select a nanotube with a diameter of 3 nm for use in the process of Colbert et al.

Claims 2-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Colbert et al. and Kong et al. as applied to claim 1 above, and further in view of Smalley et al. (PCT/US98/04513).

Kong et al. do not specifically teach that the carbon nanotubes are grown normal to the substrate. However, Smalley teaches a process whereby a macroscopic array of single-walled nanotubes may be formed on a silicon substrate by the growth of SWNTs through chemical vapor deposition and the subsequent aligning of the SWNTs using an electric field (page 13, paragraph 0158). It would have been obvious to one of ordinary skill at the time of invention to align the nanotubes of Kong et al. in a single direction, perpendicular to the substrate, in order to ease the finding of an isolated nanotube in the process of Colbert et al.

Regarding claims 3-11, Kong et al. teach the growth of single-walled nanotubes on a metallic catalyst which is supported on a silicon wafer substrate. The process of Kong involves the deposition of the metallic catalyst on the silicon substrate and the exposure of the silicon wafer to a carbon-containing gas under conditions to promote growth of single-walled nanotubes. The catalyst deposition involves a ferric salt of ferric nitrate in solution with methanol (footnote Figure 1, b). Regarding claim 11, the alcohol solvent is removed from the substrate by vaporization. The selection of one alcohol, specifically isopropanol, over another, such as methanol, would have been

obvious to one of ordinary skill in the art unless applicant shows significantly different and unexpected results.

Regarding claims 12 and 13, methane is used as the carbon-containing feedstock because it is the most kinetically stable hydrocarbon at elevated temperatures. However, it would have been obvious to one of ordinary skill to substitute ethylene for the methane feedstock of Kong et al., as it too is a commonly used carbon-containing feedstock for the chemical vapor deposition growth of single-walled carbon nanotubes.

Claims 15-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Colbert et al. and Kong et al. and Smalley et al. as applied to claim 1-3 above, and further in view of Ago et al. ("Dispersion of metal nanoparticles for aligned carbon nanotube arrays").

Kong et al. does not teach a method of depositing the metallic catalyts on the silicon wafer using metallic colloid particles. However, Ago et al. disclose a process of dispersing metallic catalyst nanoparticles on a silicon substrate which involves the use of metallic colloid particles. Specifically, a colloidal solution of nickel particles is used to deposit the catalyst onto the silicon substrate. However, it would have been obvious to one of ordinary skill at the time of invention to use a colloidal solution of an equivalent metal particle, such as iron, in order to accomplish the catalyst deposition. Ago et al. also teach that the average diameter of the catalyst nanoparticles was about 4 nm (page 79, 2nd column).

Regarding claim 18, whereas acetylene is used as the carbon-containing feedstock of Ago et al., it would have been obvious to one of ordinary skill at the time of invention to substitute ethylene, as it too is a commonly used carbon-containing feedstock for the chemical vapor deposition growth of single-walled carbon nanotubes.

Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Colbert et al. and Kong et al. as applied to claim 1 above, and further in view of Dai et al. (USPN 6,401,526).

Neither Colbert et al. nor Kong et al. teach applying a pulsed electric field. Dai et al. disclose a method of shortening nanotube tips. In this process, a voltage is applied between the tube and substrate and gradually increased until the loss of tube-substrate contact occurs as a result of nanotube shortening. This procedure allows the length of SWNTs to be reduced in steps of about 30 nm (column 7, lines 48-53). Because the normal lengths of nanotubes is in the range of 1-20 microns and the desired length of the nanotube tip is between 30 and 100 nm (column 7, lines 1-5), it would have been obvious to one of ordinary skill to use a pulsed electric field in order to perform multiple shortening steps.

It would have been obvious to one of ordinary skill at the time of invention to include the shortening step of Dai et al. in the process of Colbert et al. in order to provide excellent control of the length of the SWNT probes.

Conclusion

It is noted by the examiner that the applicant's invention has novelty over prior art methods of attaching carbon nanotubes to AFM tips. It is suggested that the independent claim, claim 1, be changed to resemble as follows.

"A method consisting of

- a) growing SWNTs on a substrate using chemical vapor deposition
- b) imaging said substrate with an atomic force microscope, comprising a tip, to attach one of said SWNTs to said tip, thereby producing a tip bearing a SWNT

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c) using said tip bearing a SWNT for atomic force microscopy”

Specifically, “comprising” is changed to “consisting of” to limit the claimed process to only the steps listed and thus distinguish it from the prior art attachment processes. Care should be taken to ensure that the dependent claims do not run afoul of the proposed ‘consisting of’ language.

The applicant’s discovery that single-walled carbon nanotubes are picked up on the tip of the atomic force microscope during imaging is not in itself patentable, as it appears to be inherent to the process of imaging and thus would occur during any AFM imaging of a nanotube-substrate assembly. However, the discovery may be exploited with a claim changed as above.

The cited Smalley reference, PCT/US98/04513, was published on 9/11/98, however a copy could not be located. A child application, which is a 371 of the PCT, is thus being sent as reference.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Peter J Lish whose telephone number is 703-308-1772. The examiner can normally be reached on 9:00-6:00 Monday through Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner’s supervisor, Stanley Silverman can be reached on 703-308-3837. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-305-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.



STUART L. HENDERSON
PRIMARY EXAMINER

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January 31, 2003